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Energy Innovation in France- Deep Offshore and Fuel Cells

Bernard BOURGEOIS

CNRS/LEPII/EPE, Grenoble, France

Presentation

- 1-Introductory comments on the two french case studies
- 2-France: Deep Offshore case study
- 3- France : Fuel Cells Case study

1-Introductory comments on the two french case studies

- Some general thinkings on innovation process within a given sector
- A recall of french characteristics at the nation level

- Warnings on the both case studies : missing interviews, and feedbacks from involved actors, a fragmented and partial list of quantitative national indicators (worse for fuel cells)

Some general thinkings on innovation process within a given sector (1)

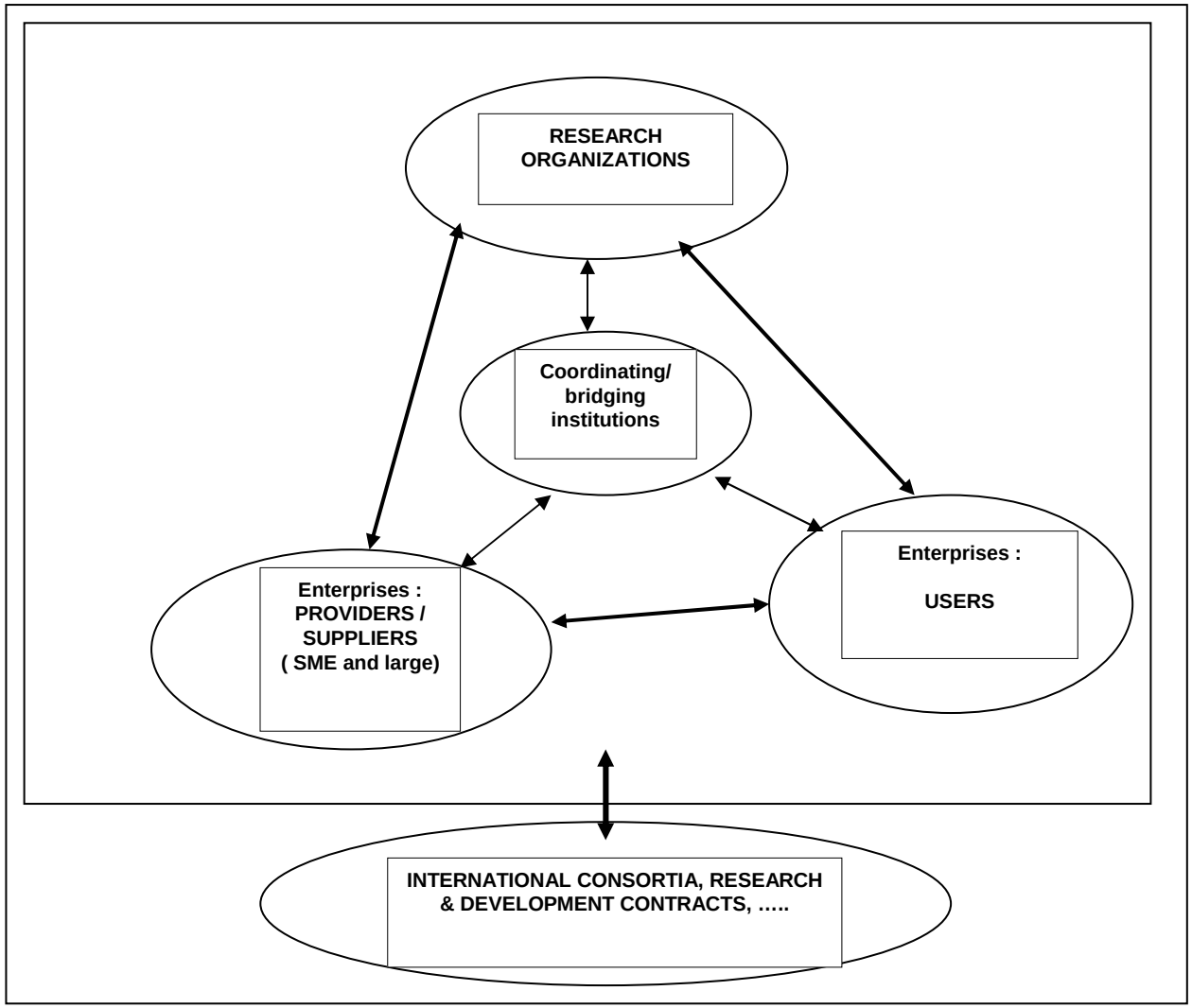
The delineation problem of the sectoral innovation system: the look for the « bridging institution »

- **Delineation problem** : the limits of the system depend upon a personnal choice : a system is defined by the personal criteria of the decision-maker- Therefore risks of wrong and not comparables choices
- **Assumption** : the core of the sectoral system is the bridging institution (s)-main coordinating hybrid institution- between the different involved actors

- **The sectoral system includes** the bridging/coordinating institution and its main actors/partners or associated institutions

Some general thinkings on innovation process within a given sector ? (2)

An open and « triadic » organization, with a coordinating institution as a common scheme



Introductory comments

National characteristics in the french innovation system

(2002 -Vignier 's report)

Area	Statistical indicators and assessment
Education and training	6% of french GDP goes to education, while 30% of employees in private sector and 45% of employees in the public sector had access to continuing professional training. France's position : **above the average**
R&D and innovation	-R&D effort put forth by French firms : insufficient (54% of R&D expenses)- Slackening in the R&D investment rate. -Rate of scientific publications (652 per Mio hab.) : within the EU average, but impact of these publications has declined -Patent application rate per capita : half of Japan or Germany- Important lag-France's position : **below the average**
Diffusion of ICT	-Household : Internet connection rate: half of the USA and Sweden rate -Firms : lower use of computer technology by employes than in UK or Sweden -School : lower use of Internet than the Eu average France's position : **below the average**
Overall performance	-**Low performance** : unemployment rate, rate of economic growth -**High performance** : labour productivity, attracting direct foreign investments, proportion of highly qualified labour force, foreign trade

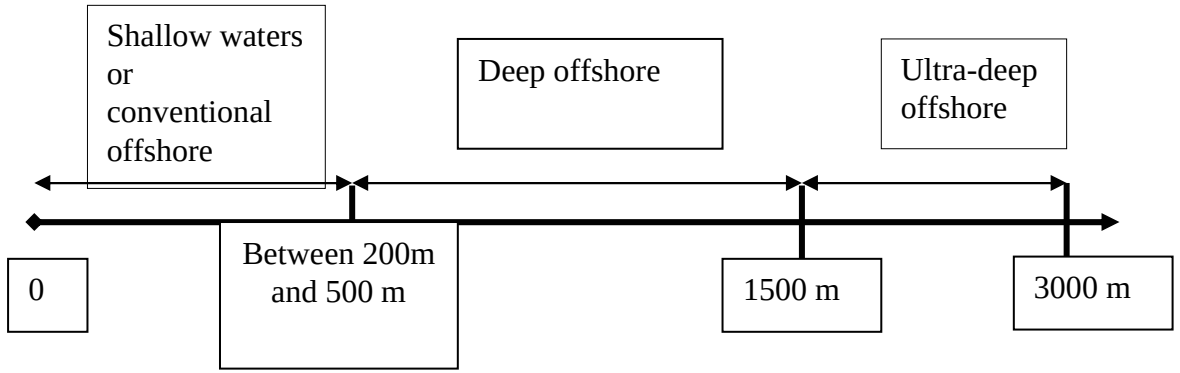
2- France : Deep Offshore case study

- A-**Organizational network: A 2003 picture of the coordinating institutions and the actors of the triad**

- B-**Innovation Processes : knowledge creation diffusion and use between the actors of the triad**

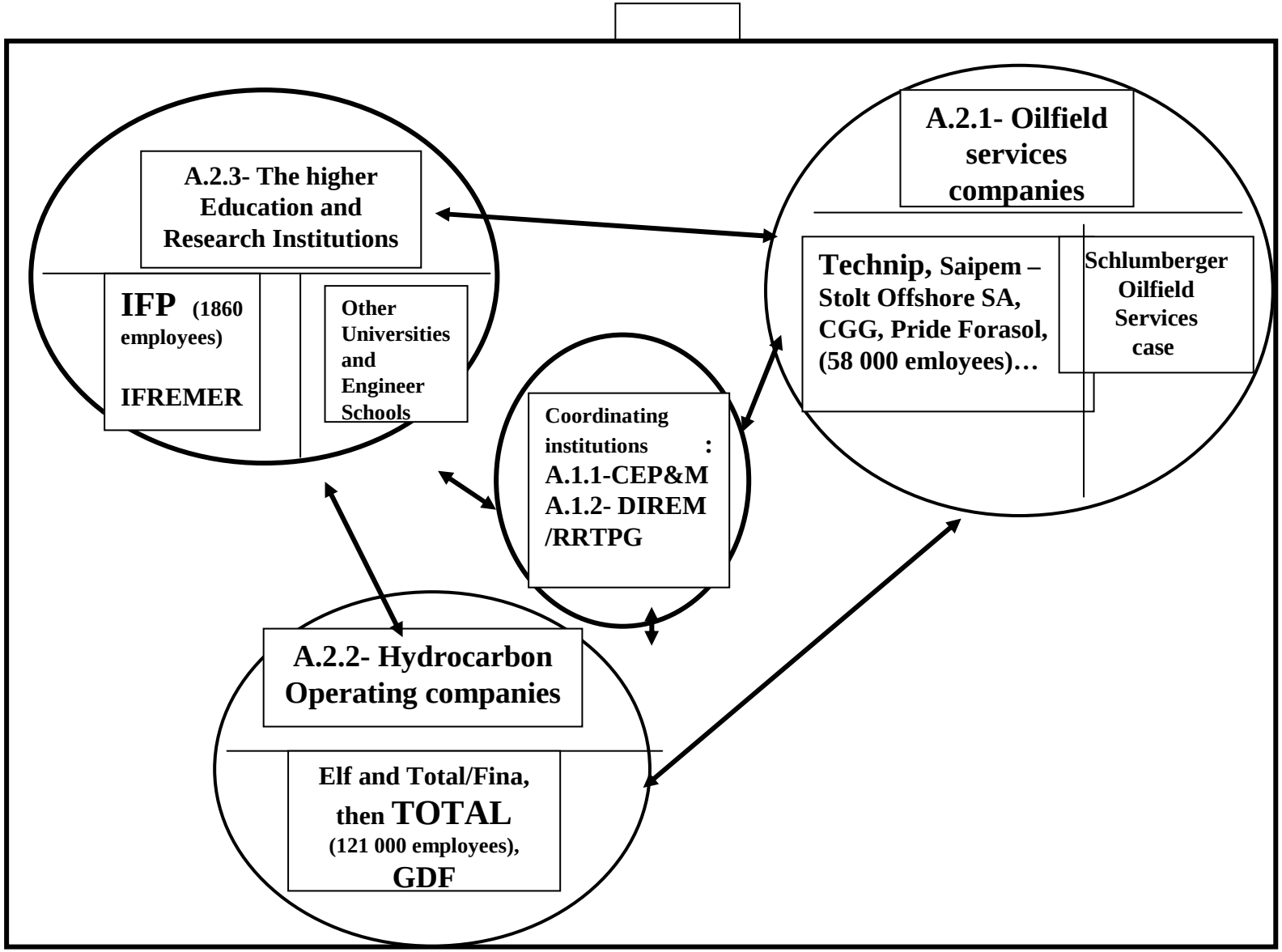
- C-**External factors that influence innovation: The international and national factors**

Introduction to deep offshore case study



- The look for the relevant “sectoral innovation system” : from deep offshore to upstream oil innovation system
- Warnings : three caveats

A-Organizational network : a 2003 picture of the coordinating institutions and the actors of the "triad" (1) : A global picture



A-Organizational network : a 2003 picture of the coordinating institutions and the actors of the "triad" (2) : The coordinating institutions

- **The technical and private body : CEP&M**
- (Comité d'Etudes Pétrolières et Marines-Hydrocarbon and subsea Committee)

- **The financial and public body : DIREM/RTPG**
- (DIREM- Directorate of Energy Ressources and Materials/ RTPG: Research Network on Oil and Gas Technology-a fund)

A-Organizational network : a 2003 picture of the coordinating institutions and the actors of the "triad" (3) :

The triad of actors (1)- Oilfield services companies (1) (2002)

Overall turnover 14,9 G€	**Share of turnover abroad** Global turnover : 14.9 G€ Turnover abroad : 13.9 G€	**Offshore turnover by branch** Suppliers and ship yards : 2.2 G€ Engineering's and services companies : 3.2 G€
Turnover by branch Vendors and ship yards : 3.7 G€ Services companies : 7.1 G€ Engineering's : 4.1 G€	**Geographical estimated share-out of turnover abroad** Africa : 20% Eastern Europe : 4% Far East : 12% Middle East : 15% N. & S. America : 26% Western Europe : 23%	**Number of employees of GEP members :** 40 000

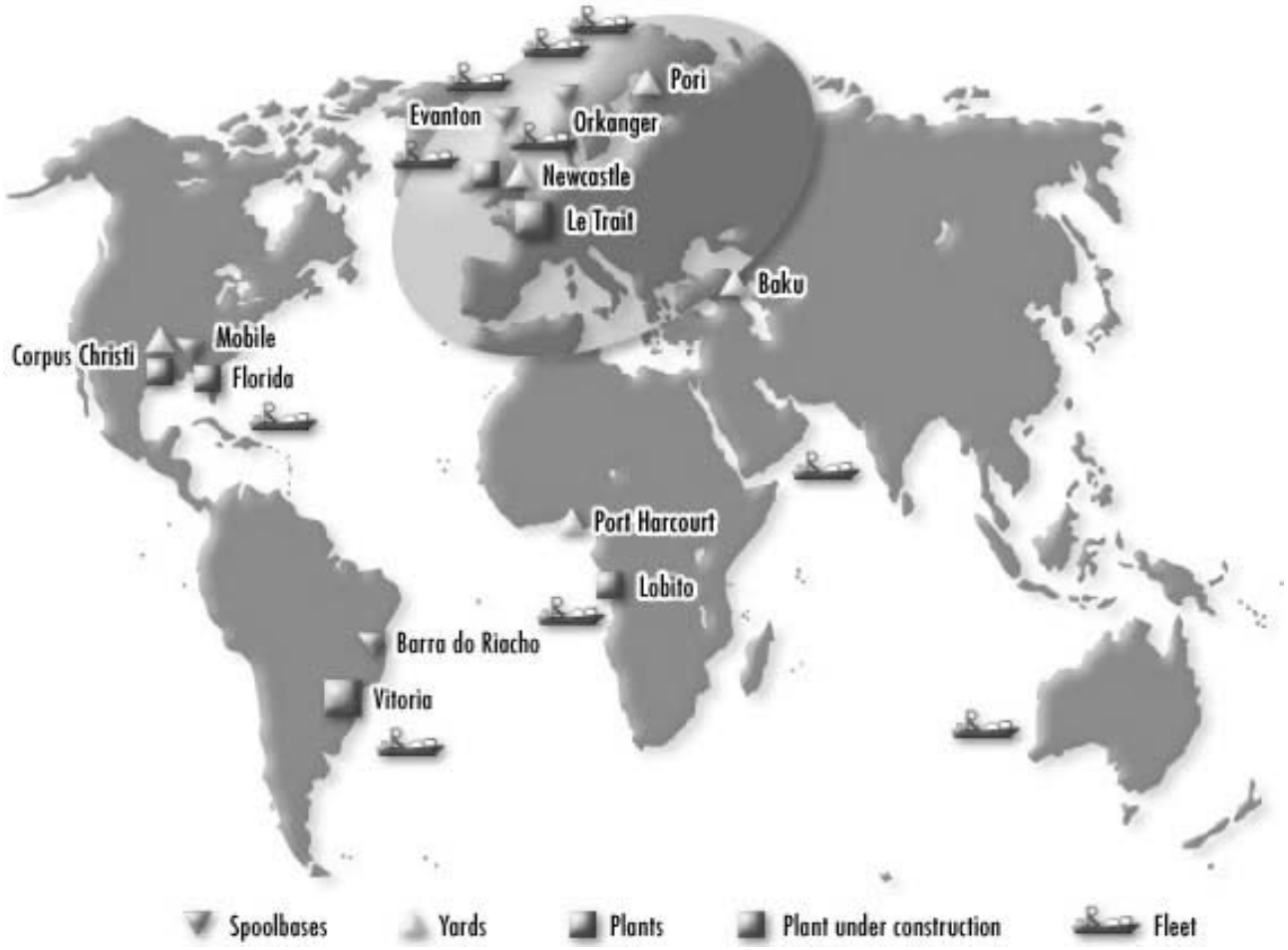
A-Organizational network : a 2003 picture of the coordinating institutions and the actors of the "triad" (4) :

The triad of actors (1)- Oilfield services companies (2) (2002)

1000 persons	Total number of employees	Offshore employees	% offshore employees
1990	38	12	31,6%
1991	40	13	32,5%
1992	44	13,5	30,7%
1993	42,5	12,5	29,4%
1994	44	11	25,0%
1995	45	12,5	27,8%
1996	47	14	29,8%
1997	51	17	33,3%
1998	53	19	35,8%
1999	51,5	17,5	34,0%
2000	51,5	17	33,0%
2001	57,9	24	41,5%
2002 (p)	58	24	41,4%

Worldwide engineering centers of the Technip group

Worldwide industrial assets of the Technip group



A-Organizational network : a 2003 picture of the coordinating institutions and the actors of the "triad" (5) :

The triad of actors (2)-The operating oil company

- Total group : (2002 figures) - Sales :121,2 G €,- Capital Expenditures : 8, 66 G €,- Net income : 6,26 G€,- Employees : (world wide) 121 000
- More than 85% of research activities have been implemented with partners
- A high share of offshore hydrocarbon production (2/3)
- Required technologies to tap non conventional hydrocarbon reserves, and particularly deep offshore ones.

- Guides the orientation of research efforts for the two others group of actors

A-Organizational network : a 2003 picture of the coordinating institutions and the actors of the "triad" (6) :

The triad of actors (3)-The Higher Education and Research Institutions : IFP

- Private and independent applied research center (1860 employees, including 891 engineers and managers)
- 80% of the total budget is supported by a public subsidy, according to a five years « Objectives Contract »
- Creation of new technologies and transfer to the other two actors of the triad, and to international market

Patents filed in….	**2000**	**2001**	**2002**
France	150	128	123
United States	134	102	97
United Kingdom	81	77	90
Germany	89	70	74
Italy	86	82	74
The Netherlands	97	78	71
Canada	58	47	41
Japan	61	54	35
Rest of the world	475	440	451
Total (all countries, all technologies)	**1231**	**1078**	**1056**

A-Organizational network : a 2003 picture of the coordinating institutions and the actors of the "triad" (7) : "The oil french paradox"

Country's rank	1st	2nd	….th	….th	….th
1- « Natural » comparative advantage (yearly 2001 oil production in 1000 tons)	**Saudi Arabia (420 763 toe)**	**USA (358 000 toe)**	**Norway 7th (161 542 toe)**	**UK 9th (118 241 toe)**	**France 57th (1 778 toe)**
2- « Technology » comparative advantage : slaes and exports of oil field equipment and services (G $)					
Turover of the oilfield services company located in…	**1- USA**	**2-Norway**	**3- UK**	**4- France**	
Export markets by the oilfield services company located in …	**1- USA**	**2-France**			

B- Innovation processes : knowledge creation diffusion and use between the actors of the triad

- **B1-Learning process within the coordinating institutions**

- **B2- The specific learning processes for the three categories of actors**

B1-Learning process within the coordinating institutions

- **The strategic discontinuities operated by CEP&M and DIREM : a shift from national oil supply safety goal towards a technology development goal**

- **the Mid-term (5 years) CEP&M plans**

- **The functional, institutional and personal complementarities between the triad**

B2- The specific learning processes for the three categories of actors :

(1)The oil services industry case

- Each corporate learning process depends upon its specific competitive environment, its current existing competences, and its strategic goals.

- The specific mix of learning possibilities (1- learning by researching, in –house R&D, 2- technology alliances, 3- acquisition or external growth) is moving with the life-cycle stages of the firm.

B2- The specific learning processes for the three categories of actors : (2)The operating industry case

- Tensions and complementarities between two cultures :
  - Competition on technology ownership
  - Competition on technology application

C-**External factors that influence innovation: The international and national factors**

- National factors

- International factors :
  - A persisting low oil price
  - Western oil companies have discovered better investment opportunities
  - Excessive competitive pressures from customers : the « procurement » paradox
  - Disincentive regulation for oil company private investment

3-France : Fuel Cells Case study

- A- Organizational network : a 2003 picture of PACo network and of the rest of actors

- B- Innovation processes : knowledge creation, diffusion and use within the PACo network

Introduction (1)

Four general facts on fuel cells innovation in 2003

- **A radical innovation, with a huge potential market in stationary and transport uses** : the very broad spectrum of required knowledge and competencies, existing and new ones;

- **Pre-commercialisation stage and uncertain future development :**the still large technical, economic and financial uncertainties that may delay, once more, the future mass-marketing stage;
- **Towards hydrogen civilisation:** the likely very long transition period before fuel cells could be supplied by large hydrogen-energy networks;
- **Expectations of the actors in the innovation race** :market share rivalry and race between large oligopolies for *learning by doing*, in the near-future.

Introduction (2)

A short historical survey of fuel cells development in France

- -1960/1975 : Starting research and technology programme within industry (Alsthom, CGE) and Research Laboratory (IFP)
- 1975/1990 : Crossing the desert, with some European oases : PCRD….
- 1991/1999 : PREDIT 1, 2, 3: (Programme Interministériel Recherche , Industrie, Transport) linking PSA, Renault, CENG and Sorapec, Universities and CNRS, plus European supports from PCRD to CNRS and University research laboratories.

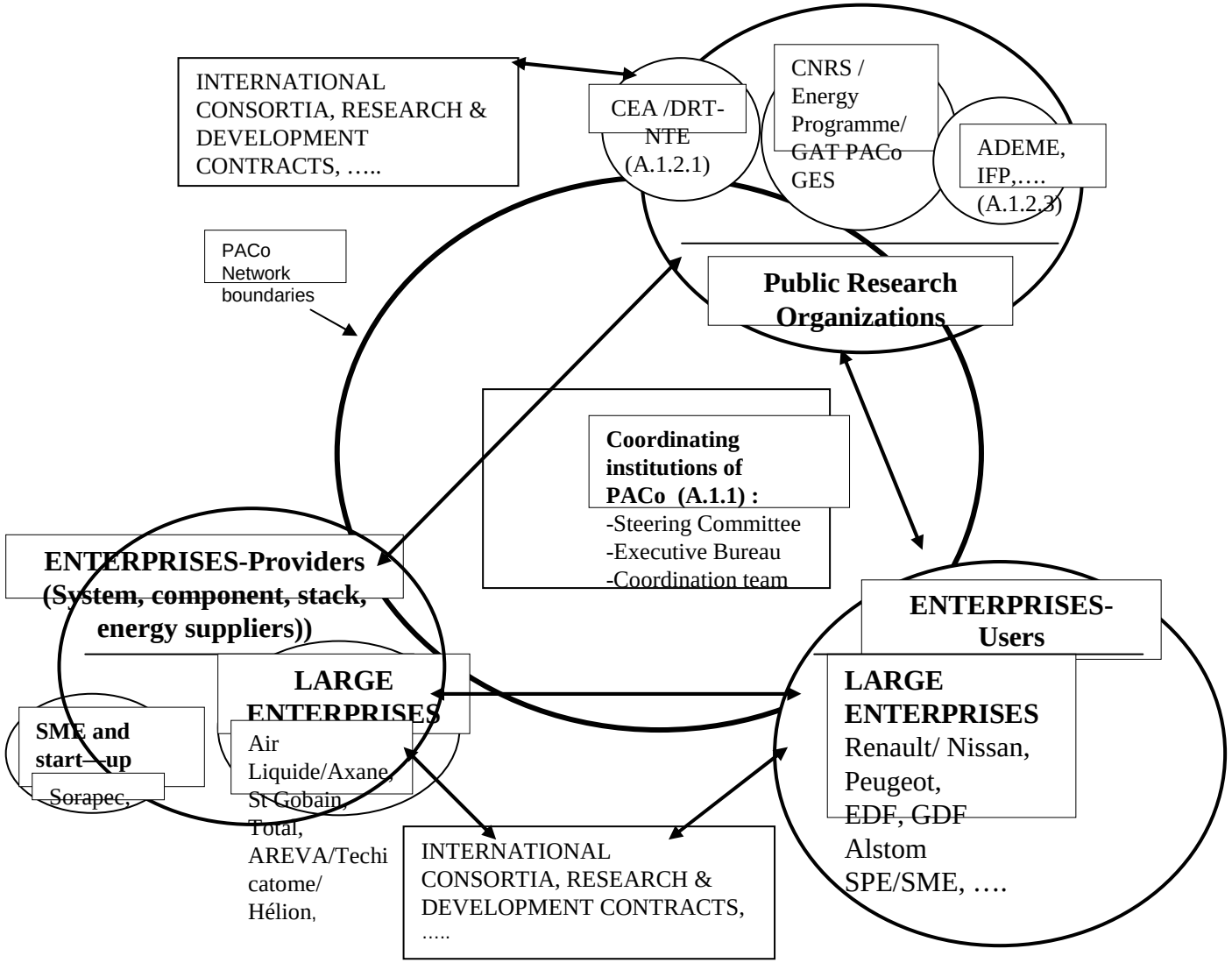
- 1997 : Diagnosis by Ministry of Economy: low french position in scientific and industrial international competitive landscape.

- 1999: Ministry of Research launches a new policy tool : the RRIT (Réseau de Recherche et d ’Innovation Technologique) with an application in fuel cells : PACo (Pile à Combustible) network.

A- Organizational network : a 2003 picture of PACo network and of the rest of actors

- 1- A 2003 picture of PACo network and of the rest of actors
- 2- The PACo network and its coordinating institutions
- 3- The Public Research Organizations associated to fuel cells development
- 4- The Enterprises : large, SME and start-up within the providers and users
- 5-Relationships between the french system and the international partners/market

A-(1)- 2003 picture of PACo network and of the rest of actors



A-2- The PACo network and its coordinating institutions (1):

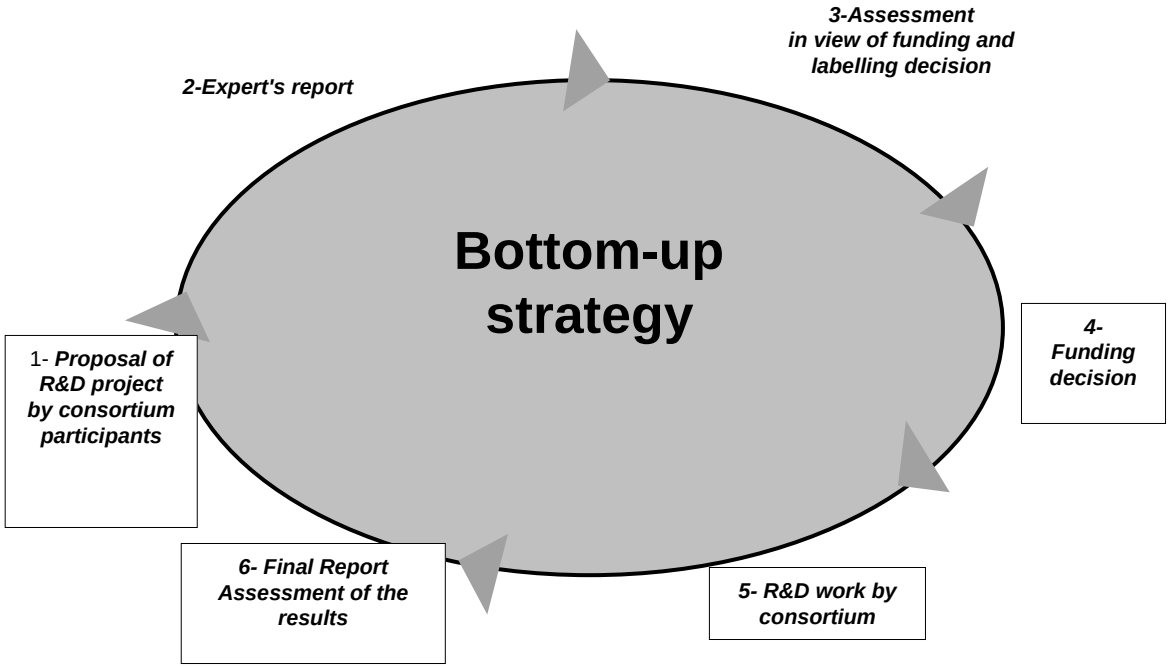
the assigned purposes of the network

- « Foster the creativity and invention needed for the commercial development of fuel cells »
- « Encourage public-private partnerships for joint R&D activities and facilitate interdisciplinary cooperation »
- « Accelerate the progress of technology from the laboratory to the market »
- « Promote the emergence of a number of industrial activities »
- « Support funding of selected R&D projects (labelling decision) »

- (Source : PACo French Fuel Cell Research and Innovation Network, 2003)

A-2- The PACo network and its coordinating institutions (2):

the organization of project 'support by the network



A-2- The PACo network and its coordinating institutions (3):

the main technology areas which have been supported

- « Small reformers supplied with different fuels (natural gas, gasoline, methanol,ethanol,…) »
- « Materials and components for hydrogen storage »
- « Materials and components of PEMFC and SOFC stacks (membranes, MEA, bipolar plates,…) »
- « Optimized design and integration of fuel cell stacks »
- « Realization of demonstrators »
- « Safety, regulations »

- (Source : PACo French Fuel Cell Research and Innovation Network, 2003)

A-2- The PACo network and its coordinating institutions (4):

the funding priorities of the network(1999/2002)

-More than 60 teams

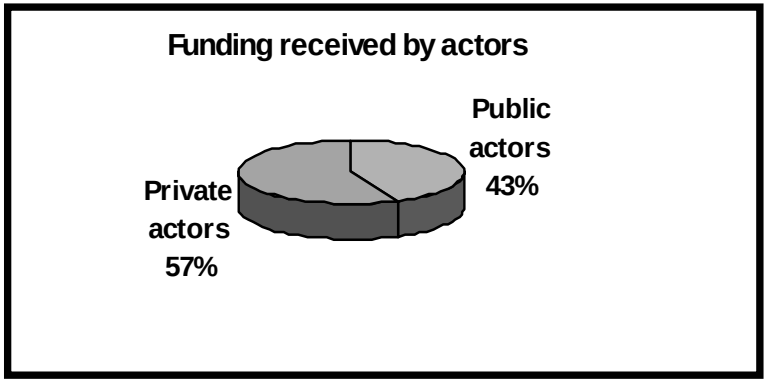
- 47 approved projects (June 03)

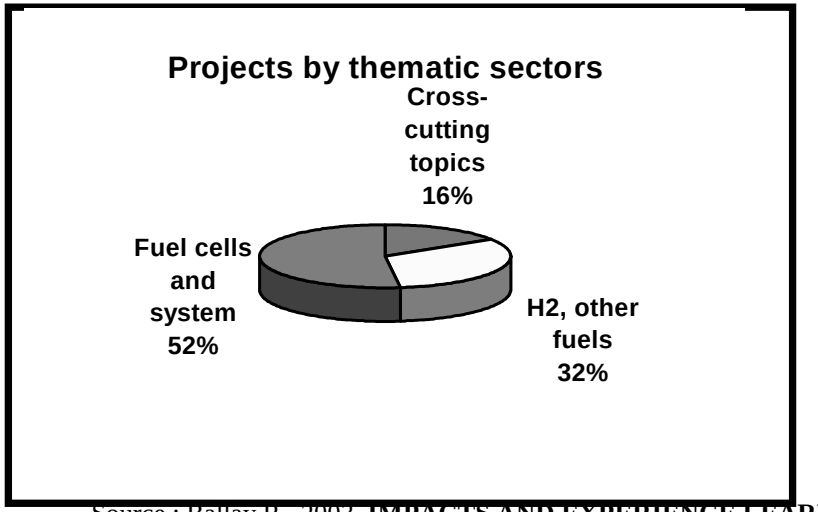
--24 projects finished or to be finished in 2003

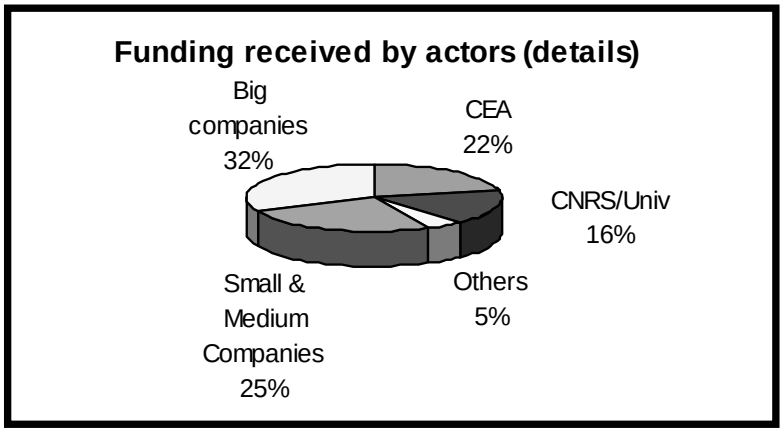
- Public funding ~ 10 M€/year

(Total funding end 2002: 32 M€)

- Ratio funding: ~ 45 %



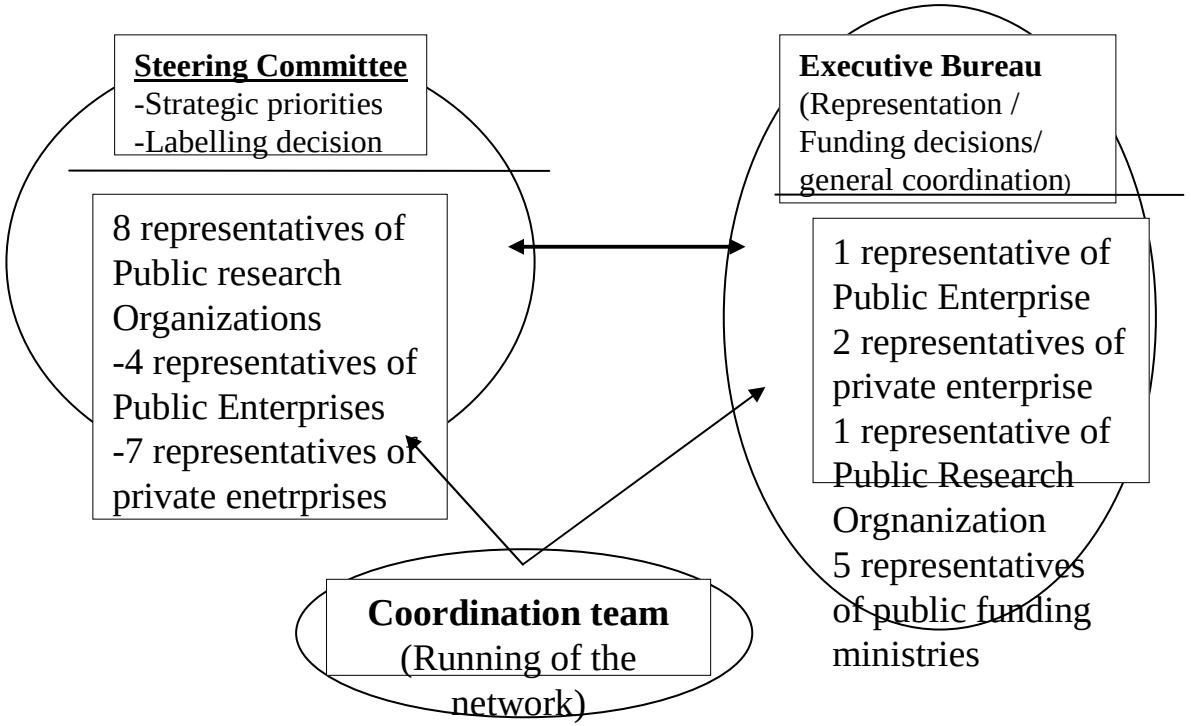




Source : Ballay R., 2003, **IMPACTS AND EXPERIENCE LEARNT FROM PUBLIC POLICY SUPPORT TO FUEL CELL TECHNOLOGY DEVELOPMENT**,**The case of the French Fuel Cell Research and Innovation Network, 1st European Hydrogen Energy Conference,** 4 September 2003, Grenoble, France

A-2- The PACo network and its coordinating institutions (5):

the composition of the coordinating institutions of PACo network



A-2- The PACo network and its coordinating institutions (6):

The funding contributions of governmental entities

	1999	2000	2001	2002	Total
Ministry of transport			2 486 186		2 486 186
Ademe		4 260 107	1 379 260	2 132 500	7 771 867
Ministry of Research	3 029 416	4 462 492	4 114 096	2 728 939	14 334 944
Ministry of Industry	4 627 085	0	1 612 215	1 141 167	7 380 467
Anvar		54 882			54 882
Total (€)	7 656 502	8 777 481	9 591 757	6 002 606	32 028 346

Source : R. Ballay, op.cit.

A-3- The Public Research Organizations associated to fuel cells development

- Commissariat à l ’Energie Atomique -CEA- DRT-DTEN: widening of ’traditional ’ R&D goals in 1995 and 1999. 75 persons within fuel cells + H2 R&D in 2002
- Centre National de la Recherche Scientifique- CNRS- Energy Programme (action concertée/ thème Fuel Cells+ Thème Hydrogen production and storage): 140 persons within these two sub-areas in 2002
- ADEME, IFP,...

A-4- The Enterprises : large, SME and start-up within the providers and users

- Large enterprises : great heterogeneity of development goals, but a rather prudent involvement in R&D expenditures, with the exception of Air Liquide; a look for international consortia, or R&D presence in USA and Japan.

- SME and start-up : some start-ups or subsidiary have been created: Helion from AREVA, Axane from Air Liquide, N-Ghy,

A-5-Relationships between the french system and the international partners/market (1) The french participation to the European PCRD projects

Thème	Nombre de projets	Participation française		Participants Français
		Nombre de projets (coordonateur français)	%	
SOFC-Stationnaire	8	5	63%	GdF ; EdF ; Turbomeca
MCFC	4	1	25%	CNRS/ENSCP
PEMFC-Stationnaire	4	1 **(1)**	25%	Technicatonme, Dalkia, CEA
PEMFC - Transport	4	4 **(2)**	100%	Axane, Schneider, Ineris, CNRS (INPG, INPT, ...) TFE, Iribus, Inrets, CEA, Air Liquide
PEMFC - Composants	4	2	50%	CEA ; CNRS (Lammi)
PEMFC - Portable	2	2 **(1)**	100%	Air Liquide, CEA, SNPE, F. Telecom,
DMFC	2	2 **(1)**	100%	Thales, CNRS (ENSCM)
Reformage	6	3 **(1)**	50%	Armines, CNRS (X2), PSA,
"Networking"	7	5	71%	PSA, Renault, IFP, CEA, Valea, EdF, GdF, Creed, Saft, Avere, Ademe, CNRS(GDR Itsofc)
	41	25 **(6)**	61% **(25%)**	

Source : Ballay R., 2003, Introduction to the 2003 Séminaire Annuel, Rséeau PACo, 2 Septembre 2003, Grenoble, France

A-5-Relationships between the french system and the international partners/market (2) The decisive reference to the competitive international landscape

- For the electrical engineering industry and for the car industry : the advances and innovations of foreign sectoral innovation system are de-facto benchmarks to appreciate lagging and leading positions of the french sectoral system.

B- Innovation processes : knowledge creation, diffusion and use within the PACo network

- 1-Learning processes within PACo network
- 2- Learning processes within Public Research Organizations
- 3- Learning processes within SME and start-up

B1-Learning processes within PACo network (1) : The interactions within the Steering committee : from the yearly review to the first global assessment of PACo network

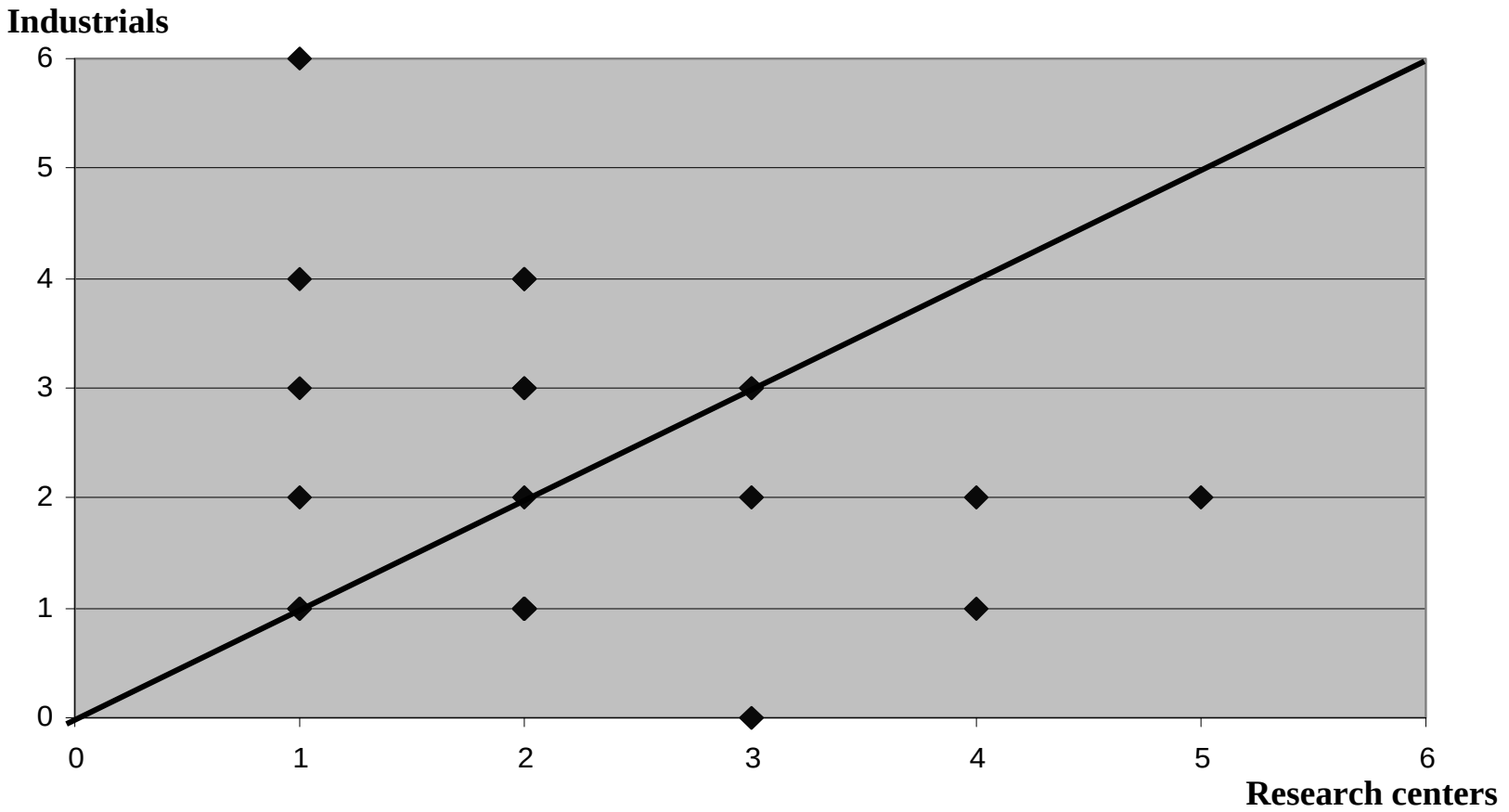
- Yearly review of the steering committee and executive bureau activities in front of a larger audience, and recall of international key events : impact on the definition of new priority for the following year

- The first global performance assessment of PACo network since its creation in June 1999 is performed since six months.

- An eventual result for the next years might be a « roadmap »

- The European Commission evolution: a likely higher involvement of Europe in fuel cells and hydrogen areas (conclusions of High Level Group- Brussels- 17th of June 2003)

B1-Learning processes within PACo network (2) : The PACo look for learning by interacting through industrial-research consortium (15 projects)



N.B-Each project is characterized by the assocation of a given number of industrials and Research Centers

Source :R.Ballay , 4 September 2003, op.cit.

B1-Learning processes within PACo network (3) : the IP dimension

- PACo authorities are looking for an increase of patents performance

(Awareness to IP) which is one « weak » point of the french NSI, but without assessing the technical follow-up; nevertheless they care ,at the beginning of the project, about an effective agreement on that issue between the different innovation stakeholders.

- But diverse positions are expressed on that indicator within the particular case of fuel cells technology

- Helion managers are convinced that an advanced technology such as FC can only be steered and developped thanks to a very rigourous and persistent policy of patent protection

- Sorapec management had a different view : »the Company believes that reliance upon unpatented know-how and on the continued introduction of improvements and new products, are generally as important as patent protection in establishing and maintaining a competitive advantage.In general, however, it is the Company policy to patent specific technological innovations and to maintain as trade secrets production methods » (EC Power Internet site)

B-2- Learning processes within Public Research Organizations

- Structuring, publication, patent and partnership efforts within CNRS.

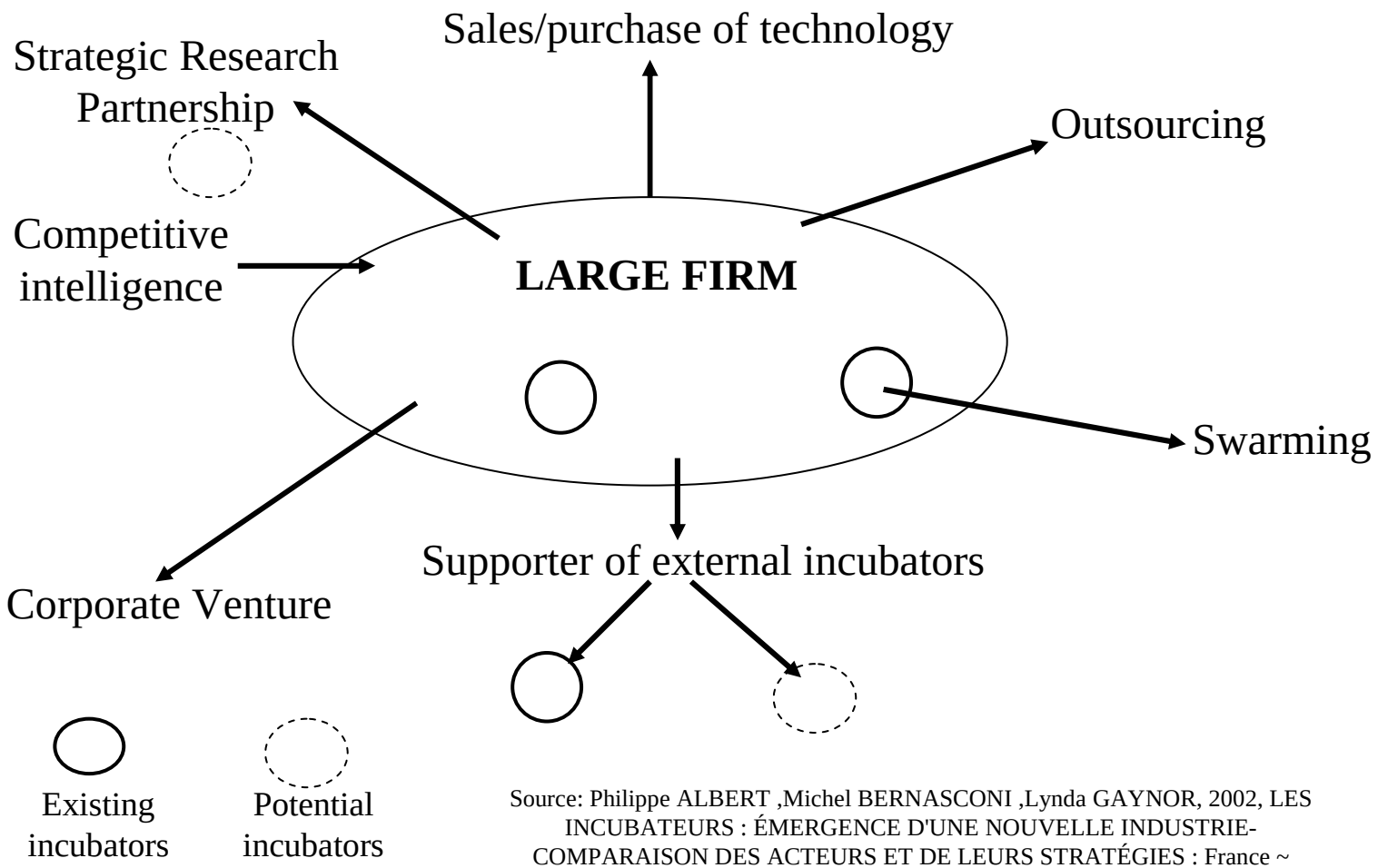
- CEA : increase of the partnership with industries at national level, and research consortia at international level (cf: the recent agreements of CEA with Air Liquide, Atofina,and SNPE/SME).

- Look for better coordination in financing the « Basic Technology research » which is involved in fuel cell case to solve the « technological bottleneck » (verrous technologiques) which are still existing.

B-3- Learning processes within SME and start-up:

The broad learning scope for large companies

(dynamic complementarities between large incumbent companies and innovative but fragile start-up)



Source: Philippe ALBERT ,Michel BERNASCONI ,Lynda GAYNOR, 2002, LES INCUBATEURS : ÉMERGENCE D'UNE NOUVELLE INDUSTRIE- COMPARAISON DES ACTEURS ET DE LEURS STRATÉGIES : France ~ Allemagne ~ Royaume Uni ~ Etats-Unis, Minefi, DIGITIP, *Avril 2002*,*Rapport de recherche*

B-3- Learning processes within large companies (2):

The look for diversified and international partnerships by large companies to master the uncertainties and complexities of fuel cells development

- The Renault ’s case:

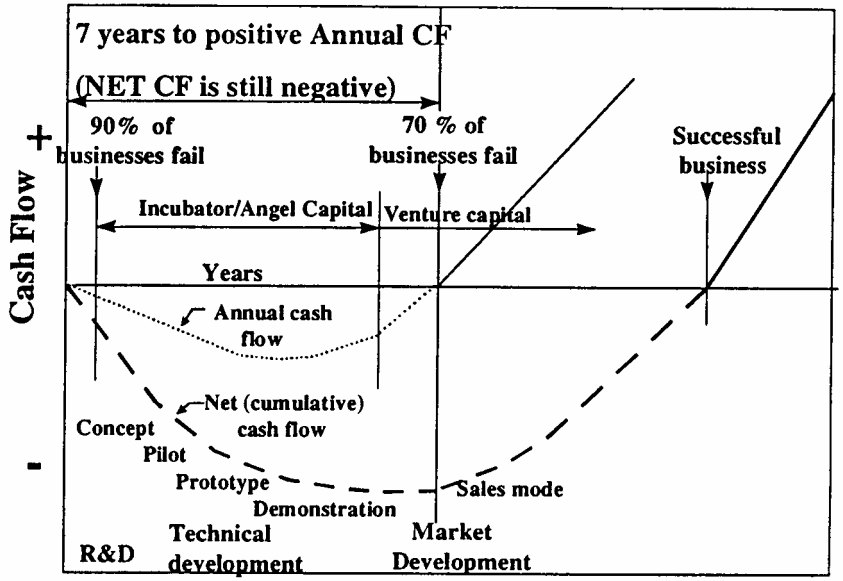
- “Renault is developing partnerships with "potential" suppliers, and Nissan is developing "in house" the stack and some electrical parts.

  Of course, we are strongly involved into public funded projects (USA, Japan, Europe) because we are conscious that the Renault-Nissan group is unable to solve all the problems by itself ; and we believe in the necessity to combine our competencies, not only between car-makers but also with other industries concerned with hydrogen”.

- (Source : HYDROGEN ECONOMY AND THE AUTOMOTIVE INDUSTRY ,THE RENAULT-NISSAN VIEW (1st EUROPEAN HYDROGEN ENERGY CONFERENCE at GRENOBLE on SEPTEMBER 2, 2003,Pierre BEUZIT, Vice President Research, RENAULT Group)

B-4- Learning processes within SME and start-up:
Death Valley problems are relevant in the fuel cells case

(the difficulties of the three solutions : increase volume of production, discover high value niche market, early market development)



Source : Mountain of death : From the Electric Power Research Institute; Valley of death from Helena Chum, and Irvin Barash, Ven Com Management, plus mitchell 1995: Graham R. Mitchell, Partnerships between government and industry, in "Vannevar Bush II: Science for the 21st Century, Forum proceedings, March 2-3, 1995, Sigma Xi, Research Triangle Park, NC.
Reproduced in Holdren J.P., 1997, Report to the President on Federal Energy Research and Development for the challenges of the twenty-first century, President's Committee of Advisors on Science and Technology (PCAST) -Panel on Energy research and Development, November 1997, US White House Government,
http: //www.whitehouse.gov/WH/EOP/OSTP/Energy/tocpdf.html. Page 7-15